Mission Directorate:	Science
Theme:	James Webb Space Telescope

Theme Overview

The James Webb Space Telescope (JWST) is a flagship mission and essential contributor to NASA's goal in astrophysics to "discover how the universe works, explore how the universe began and evolved, and search for Earth-like planets." JWST contributes to answering a broad scientific question emanating from this goal: How did the universe originate and evolve to produce the galaxies, stars, and planets we see today? By being able to look back into the history of the universe, to see the first light from the first stars, JWST enables the study of how galaxies, stars and planetary systems came into being, how they evolve, and ultimately how they end their lives. Additionally, the mission will make discoveries that will help scientists understand how matter, energy, space, and time behave under the extraordinarily diverse conditions of the cosmos, and the characteristics of planetary systems orbiting other stars.

Because of the significance of the JWST, a new theme was created. The elevation of JWST to its own theme reflects management changes implemented in FY 2011 to improve oversight and control over the project in direct response to the Independent Comprehensive Review Panel's (ICRP) report in November 2010. The project, which was previously managed within the Science Mission Directorate's (SMD) Astrophysics Division within NASA Headquarters, and was part of the Cosmic Origins Program, is now managed via a separate program office at NASA Headquarters. The JWST Project Manager at Headquarters now reports directly to NASA's Associate Administrator and the Associate Administrator of SMD. The lead Center for JWST, Goddard Space Flight Center (GSFC). has also implemented changes, with project management now reporting directly to the Center Director.

Note that the technical content of the JWST project has not changed as a result of any of these management changes, and in fact the changes have been made in recognition of the high importance of this mission for the Agency and the astrophysics community.

JWST was again included as a high priority in the most recently released National Academies decadal survey for astronomy and astrophysics entitled "New Worlds, New Horizons in Astronomy and Astrophysics" (National Academies, 2010). The project remains an integral part of SMD's portfolio of bold new Astrophysics initiatives that open the universe to reveal new discoveries. JWST was the top priority of earlier decadal surveys, and helps to provide the foundational science upon which the new projects of the latest survey depend.

The JWST theme will achieve its objectives via the analysis of scientific data from a 6.5-meter cryogenic telescope launched to the Sun-Earth Lagrangian 2 (L2) point and operated for a minimum of five years.

For more information, please see http://www.jwst.nasa.gov/.

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**438.7**	**-**	**354.6**	**359.3**	**365.3**	**371.6**	**371.6**
James Webb Space Telescope	438.7	-	354.6	359.3	365.3	371.6	371.6

Note: The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the program amounts shown above. The allocation to each program is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Plans for FY 2012

James Webb Space Telescope

The James Webb Space Telescope will continue fabrication, integration, and testing in support of a launch date to be determined following a comprehensive re-planning of all project cost and schedule elements.

Relevance

Relevance to national priorities, relevant fields, and customer needs:

JWST is guided by the Space Act and subsequent legislation, and by U.S. National Space Policy and related policies, which call on NASA to conduct space missions to advance scientific understanding of the universe. In doing so, NASA follows a long-standing tradition of establishing its science priorities through consultation with world-class experts via the National Academies decadal survey process. The most recent astrophysics decadal survey was released in August 2010, and includes JWST as part of its recommended set of missions. JWST also receives advice from the external science community via the Astrophysics Subcommittee of the NASA Advisory Council, and advice on cooperative activities from the Congressionally chartered, National Science Foundation (NSF)-managed Astronomy and Astrophysics Advisory Committee. JWST remains a high priority within the astrophysics and broader science communities.

Relevance to the NASA Mission and Strategic Goals:

NASA's astrophysics missions seek to discover how the universe works, explore how it began and evolved, and search for Earth-like planets. JWST will contribute substantially to each of these strategic goals. JWST will improve estimates for the Hubble constant and thereby provide tighter constraints on the nature of dark energy. The infrared sensitivity of JWST will allow researchers to study the first stars and galaxies to form after the Big Bang. Using the combination of spectroscopy and coronographic imaging JWST will study exoplanets and their atmospheric compositions.

Relevance to education and public benefits:

JWST has a strong education and public outreach program. JWST is included in the consortium of Astrophysics missions featured in a traveling museum exhibit, "Alien Earths," that informs and inspires the public on critical questions related to the search for life elsewhere in our universe. In addition, JWST's website has educational materials for educators, including lesson plans, activities and programs that enable students to help solve real-world JWST problems, compare simple telescopes to JWST, learn about planets outside our solar system, solve space math problems, understand light and telescopes, learn how JWST's mirrors are built, and understand infrared energy. For more information, see http://www.jwst.nasa.gov/teachers.html.

Performance

Performance Commitments:

Measure #	Description	Contributing Program (s)
Strategic Goal 2	**Expand scientific understanding of the Earth and the universe in which we live.**	
Outcome 2.4	**Discover how the universe works, explore how it began and evolved, and search for Earth-like planets.**	
Objective 2.4.2	**Improve understanding of the many phenomena and processes associated with galaxy, stellar, and planetary system formation and evolution from the earliest epochs to today.**	
Performance Goal 2.4.2.2	***Design and assemble James Webb Space Telescope (JWST).***	
APG 2.4.2.2: JWST-12-1	Begin integration of James Webb Space Telescope (JWST) flight optics into Optical Telescope Element (OTE).	James Webb Space Telescope

Performance Achievement Highlights:

JWST is making good technical progress. The JWST Program passed its mission Critical Design Review (CDR) in the Spring of 2010. This is a major milestone for the program and marks the transition into full manufacturing and assembly phase of observatory hardware. All 18 flight Primary Mirror segments have completed initial polishing, and several have completed final polishing and have received reflective coating. The flight Mid-Infrared Instrument (MIRI) instrument successfully completed all vibration testing, and the flight Near Infrared Spectrograph (NIRSpec) instrument is completely assembled and has also successfully completed vibration testing.

One of the recommendations from the CDR was to complete an in-depth evaluation of the integration and testing plan for JWST. The Test Assessment Team (TAT) identified a significant number of opportunities to optimize the Optical Telescope Element/ Integrated Science Module test plan at the Johnson Space Center (JSC) and the Integrated Science Instrument Module testing at GSFC that will better manage the overall technical and programmatic risk to the mission. The TAT also recommended that JWST should quickly establish a new integration and testing leadership position to optimize planning for the remaining tests, and this recommendation has now been implemented.

Mission Directorate:	Science
Theme:	James Webb Space Telescope
Program:	James Webb Space Telescope

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**438.7**	**-**	**354.6**	**359.3**	**365.3**	**371.6**	**371.6**
James Webb Space Telescope	438.7	-	354.6	359.3	365.3	371.6	371.6

Note:

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Project Descriptions and Explanation of Changes

James Webb Space Telescope

JWST is the only project within this Program and Theme, as a result of the recent changes in management structure to increase management oversight and control of the project. JWST is currently in development phase and will launch on a European Space Agency (ESA)-supplied Ariane 5 rocket for a five-year science mission to study the origin and evolution of galaxies, stars, and planetary systems. The JWST spacecraft will have a large array of mirrors, 21.3 feet in diameter, and a sunshield the size of a tennis court. Neither the mirror assembly nor the sunshield fit into the rocket fully open, so both will fold up and open only after JWST is in space. JWST will reside in space at the Sun-Earth L2 point, which is about one million miles from Earth. The telescope and instruments will operate at cryogenic temperature in order to achieve infrared performance.

Considering the Independent Comprehensive Review Panel's (ICRP) findings and recommendations, NASA is undertaking a re-planning activity to determine a feasible and appropriate the schedule for completing the remaining work on JWST given the budget provided. This new project schedule (and associated determination of a new JWST launch date) will be completed during FY 2011. Items to be highlighted in this revised schedule include a schedule for the remaining modifications to the thermal vacuum Chamber A at the Johnson Space Center (see the Construction of Facilities section for more detail on this project). Final decisions resulting from this replanning activity will be reflected in the President's FY 2013 budget.

Program Management

The new NASA Headquarters JWST Program Director reports directly to the NASA Associate Administrator (AA) and Science AA. At GSFC, the project reports directly to the Center Director.

Mission Directorate:	Science
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Program:	James Webb Space Telescope
Project In Development:	James Webb Space Telescope

FY 2012 Budget Request

Budget Authority ($ millions)	Prior	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**2,552.3**	**438.7**	**-**	**354.6**	**359.3**	**365.3**	**371.6**	**371.6**

Note: The JWST budget total will be determined as part of the project replan to be completed in 2011.

For the FY 2012 Budget Request, project life cycle estimates, required to meet the requirements of section 103 of the NASA Authorization Act of 2005 (P.L. 109-155; 42 U.S.C. 16613), have been consolidated in the Management and Performance Section of this document. This consolidation provides for a comparative analysis across projects, and the inclusion of corrective action plans for the projects that have exceeded their original baseline estimates by greater than fifteen percent.

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Explanation of Project Changes

During 2010, JWST identified cost growth and schedule issues, which resulted in the formation of the ICRP. The ICRP charter was to determine the technical, management, and budgetary root causes of cost growth and schedule delay on JWST, to estimate the minimum cost to launch JWST, and to assess the associated launch date and budget profile. The ICRP report concluded that the problems causing cost growth and schedule delays on the JWST project are primarily associated with cost estimation and program management. The panel recommended several managerial changes at Headquarters and GSFC and some of these have already been implemented. The schedule for completing the JWST project within the budget provided will be re-evaluated as part of a replanning activity and a new plan is expected in 2011. The results of this re-planning activity will be presented to Congress immediately upon completion of the work. In addition, NASA will keep Congress apprised of progress during development of the new baseline.

As indicated in NASA's letter to Congress on October 28, 2010, it is certain that the JWST baseline development cost and launch readiness date will be exceeded by more than 15 percent and six months.

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Theme:	James Webb Space Telescope
Program:	James Webb Space Telescope
Project In Development:	James Webb Space Telescope

Project Purpose

JWST is a large, deployable, space-based infrared astronomical observatory. The mission is a logical successor to the Hubble Space Telescope (HST), extending beyond Hubble's discoveries by looking into the infrared spectrum, where the highly red-shifted early universe must be observed, where cool objects like protostars and protoplanetary disks emit infrared light strongly, and where dust obscures shorter wavelengths.

The four main science goals are to:

- Search for the first galaxies or luminous objects formed after the Big Bang;

- Determine how galaxies evolved from their formation until now;

- Observe the formation of stars from the first stages to the formation of planetary systems; and

- Measure the physical and chemical properties of planetary systems and investigate the potential for life in those systems.

Hubble has greatly improved knowledge about distant objects, but its infrared coverage is limited. Light from distant galaxies is redshifted by the expansion of the universe into the infrared part of the spectrum (from the visible). By examining light redshifted beyond Hubble's sight, JWST will be able to observe things farther away, as their light has taken longer to reach us. Hence it will be looking back further in time.

JWST will explore the mysterious epoch when the first luminous objects in the universe came into being after the Big Bang. The focus of scientific study will include first light of the universe, assembly of galaxies, origins of stars and planetary systems, and origins of the elements necessary for life.

The telescope will launch from Kourou, French Guiana, on a ESA-supplied Ariane 5 rocket. Its operational location is the L2 point, which is about one million miles from Earth.

For more information, please see: http://www.jwst.nasa.gov.

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Project Parameters

JWST will be optimized for infrared astronomy, with some capability in the visible range. JWST's instruments are the Near Infrared Camera (NIRCam), MIRI, NIRSpec, and the Fine Guidance Sensor (FGS).

NIRCam is an imager with a large field of view and high angular resolution. It covers a wavelength range of 0.6 - 5 micrometers and has 10 mercury-cadmium-telluride (HgCdTe) detector arrays. These are analogous to charge coupled devices found in ordinary digital cameras. NIRCam is a science instrument but also a wavefront sensor, which is used to align and focus the optical telescope.

NIRSpec enables scientists to obtain simultaneous spectra of more than 100 objects in a 9-square-arcminute field of view. It provides medium-resolution spectroscopy over a wavelength range from 0.6 - 5 micrometers. NIRSpec employs a micro-electromechanical system "microshutter array" for aperture control, and it has two HgCdTe detector arrays.

MIRI is an imager/spectrograph that covers the wavelength range of 5 - 28 micrometers and it has three arsenic-doped silicon detector arrays. The camera module provides wide-field broadband imagery, and the spectrograph module provides medium-resolution spectroscopy over a smaller field of view compared to the imager. The nominal operating temperature for MIRI is 7 degrees above absolute zero, which is possible through an on-board cooling system.

The FGS is a guider camera that is incorporated into the instrument payload in order to meet the image motion requirements of JWST. This sensor is used for both guide star acquisition and fine pointing. The sensor operates over a wavelength range of 1 - 5 micrometers and has two HgCdTe detector arrays. Its field of view provides a 95 percent probability of acquiring a guide star for any valid pointing direction. The FGS tunable filter camera is a wide-field, narrow-band camera that provides imagery over a wavelength range of 1.6 - 4.9 micrometers, via tunable Fabry-Perot etalons that are configured to illuminate the detector array with a single order of interference at a user-selected wavelength. The camera has a single HgCdTe detector array.

The JWST ground operations, Science Support Center, and archives will be at the Space Telescope Science Institute in Baltimore, MD.

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Project Commitments

After launch, JWST will complete six months of on-orbit checkout and commissioning and five years of prime mission operations. JWST has a goal of 10 years of operations.

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
Observatory	Northrop Grumman Aerospace Systems, Redondo Beach, California	Includes Optical Telescope Element (OTE), Spacecraft, Sunshield, Observatory AI&T and commissioning. The Observatory shall be designed for at least a 5-year lifetime.	Same	Same
Integrated Science Instrument Module (ISIM)	NASA Goddard Space Flight Center	Contains the Science Instruments (SIs) and Fine Guidance Sensor (FGS). Provides structural, thermal, power, command and data handling resources to the SIs and FGS.	Same	Same
Near-Infrared Camera (NIRCam) instrument	University of Arizona; Lockheed Martin	Optimized for finding first light sources, and operating over the wavelength range 0.6-5 microns.	Same	Same
Near-Infrared Spectrometer (NIRSpec)	European Space Agency (ESA)	Operating over the wavelength range 0.6-5 microns with three observing modes.	Same	Same
Mid-Infrared Instrument (MIRI)	ESA; University of Arizona; Jet Propulsion Laboratory	Operating over the wavelength range 5-27 microns, providing imaging, coronagraphy, and spectroscopy.	Same	Same
Fine Guidance Sensor	Canadian Space Agency (CSA)	Provides scientific target pointing information to the observatory's attitude control sub-system.	Same	Same
Launch Vehicle	European Space Agency (ESA)	Ariane V ECA	Same	Same
Science Operations Center and Mission Operations	Space Telescope Science Institute (STScI)	Mission Operations and Science Operations Center	Same	Same

Mission Directorate:	Science
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Schedule Commitments

JWST was approved to enter implementation in July 2008 and completed CDR in April 2010.

The JWST project schedule, given the budget provided, is being re-evaluated as part of a re-planning activity and a new plan is expected in 2011. The results of this re-planning activity will be presented to Congress immediately upon completion of the work. In addition, NASA will keep Congress apprised of progress during development of the new baseline.

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Development			
Non-Advocate Review/Preliminary Design Review	March,2008	Same	Same
Start phase C/Implementation	July 2008	Same	Same
Critical Design Review	April 2010	Same	Same
Systems Integration Review (SIR)	May 2012	February 2013	TBD
Launch Readiness Date	June 2014	Same	TBD
Start Phase E	December 2014	Same	TBD

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Project Management

Goddard Space Flight Center is responsible for JWST project management.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Observatory	GSFC	GSFC	None
Mission management and System Engineering	GSFC	GSFC	None
Integrated Science Instrument Module (ISIM)	GSFC	GSFC	None
NIRCam	GSFC	GSFC	None
NIRSpec	ESA	None	ESA
MIRI	GSFC	JPL, ARC	ESA
Fine Guidance Sensor - Tunable Filter (FGS-TF)	CSA	None	CSA
Ariane 5 ESA launch vehicle and launch operations	ESA	None	ESA
Ground control systems and science operations and control center	GSFC	None	None

Acquisition Strategy

JWST is being built by Northrop Grumman Aerospace Systems (Redondo Beach, CA), with major subcontractors including Ball Aerospace (Boulder, CO), ITT (Rochester, NY), and Alliant Techsystems (Edina, MN). Selections were made via a NASA request for proposal.

The Space Telescope Science Institute (STScI), in Baltimore, MD, is developing the Science and Operations Center and associated services.

The Integrated Science Instrument Module (ISIM) is being provided by GSFC.

The University of Arizona at Tucson is providing NIRCam, along with Lockheed Martin's Advanced Technology Center in Palo Alto, CA. The selection was made via a NASA announcement of opportunity.

ESA is providing MIRI, with management and technical participation by ARC and JPL. ARC and JPL were selected for this role after an internal NASA competition. ESA is also providing NIRSpec and an Ariane 5 launch vehicle.

The Canadian Space Agency is providing the Fine Guidance Sensor.

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Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	SRB	04/2010	Critical Design Review. SRB found that mission design is mature and recommended a more in depth review of the integration and testing plan.	TBD
Quality	Test Assessment Team	08/2010	The TAT evaluated JWST plans for integration and testing. The TAT recommended several changes to the test plan. See the full report at http://www.jwst.nasa.gov/publications.html.	n/a
Other	Independent Comprehensive Review Panel	10/2010	The ICRP charter was to determine the technical, management and budgetary root causes of cost growth and schedule delay on JWST, and estimate the minimum cost to launch JWST, along with the associated launch date and budget profile, including adequate reserves. The report made 22 recommendations covering several areas of management and performance.	n/a
Performance	SRB	N/A	Systems Integration Review	TBD
Performance	SRB	N/A	Flight Readiness Review	TBD

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
JWST Cost and Schedule Growth	Projected FY 2011 ISIM and Northrop Grumman Aerospace Systems cost growth will exceed available budget, resulting in a work delay, and delaying the LRD. Inclusion of SRB-recommended verification enhancements will further impact cost and schedule.	Project replan is underway and will be complete in 2011.
JWST Sunshield Deployment	If the sunshield fails to deploy to its prescribed operational shape then mission science requirements cannot be met.	Full-scale deployment demonstration test bed will be used to verify all deployment designs. Extensive deployment testing will be conducted at temperature of all sunshield assemblies and components.